Climbing Ropes—Environmental Hotspots in Their Life Cycle and Potentials for Optimization

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Introduction and Methods

A company carbon footprint analysis conducted by the Mammut Sports Group AG (hereafter Mammut), a multinational mountaineering company based in Seon (Switzerland), revealed that climbing ropes account for 13 % of Mammut's global carbon footprint [1]. Due to the high share of climbing ropes in the company carbon footprint, this study further examines the environmental impact of this product by conducting a life cycle assessment (LCA). There were no public studies available on the environmental impact of climbing ropes besides the carbon footprint analysis of Mammut.
The production data for the climbing ropes were provided by Mammut. To gather recent data on the use and the end-of-life phases as well as the user behavior of the climbers a quantitative research design with an international online survey was applied (n = 1450). Mammut is conducting a project in which old climbing ropes are collected and recycled in an open-loop. The recycled polyamide will be reused for non-personal protective equipment products, such as a T-shirt, as it cannot meet the high functional requirements as a base material for climbing ropes.

Figure 1. Rope braiding machine. Source: Aargauer Zeitung

Goal and Scope

The goal of this research was to comprehensively analyze potential environmental impacts in the life cycle of a climbing rope and to identify environmental hotspots and mitigation potentials. Furthermore, the potential of a recycling project was evaluated. The weight of Mammut's best-selling rope in 2019 was defined as the functional unit: the 9.5 Infinity Classic/Dry is 60 m long and weighs 3.54 kg [2]. The system boundaries included the production, usage and disposal phases. In a further scenario, the emissions avoided through the potential open-loop recycling project (saved polyester and avoided disposal) were also considered. The environmental impact of the recycling process itself was not included. The system boundaries apply for the rope production for Mammut in Europe in the reference year 2018.

Results

According to this study [3], the life cycle of the functional unit, the climbing rope Infinity Classic/Dry from Mammut (60 m), causes greenhouse gas (GHG) emissions of 46.6 kg CO_2-eq. Polyamide 6 represents the major environmental hotspot along the life cycle of the climbing rope, contributing at 50% the most to the greenhouse gas (GHG) emissions (figure 2) and on most of the other environmental issues (figure 3). Rope processing has the greatest impact on ozone depletion and freshwater eutrophication. Coal as an energy source for the production site is responsible for the emissions into the freshwater. 96.5% of the high impact on ozone depletion is caused by ethane emissions occurring during the production of the impregnating agent. With 7.58 kg CO_2-eq., rope disposal contributes 16% to the GHG emissions of the climbing rope, mainly derived from the incineration of the rope. According to the survey the willingness to return the rope at the end of its service life, as part of Mammut's recycling project, can be rated as high with a mean of 4.01 and a median of 4 (1 = very unlikely; 5 = very likely).

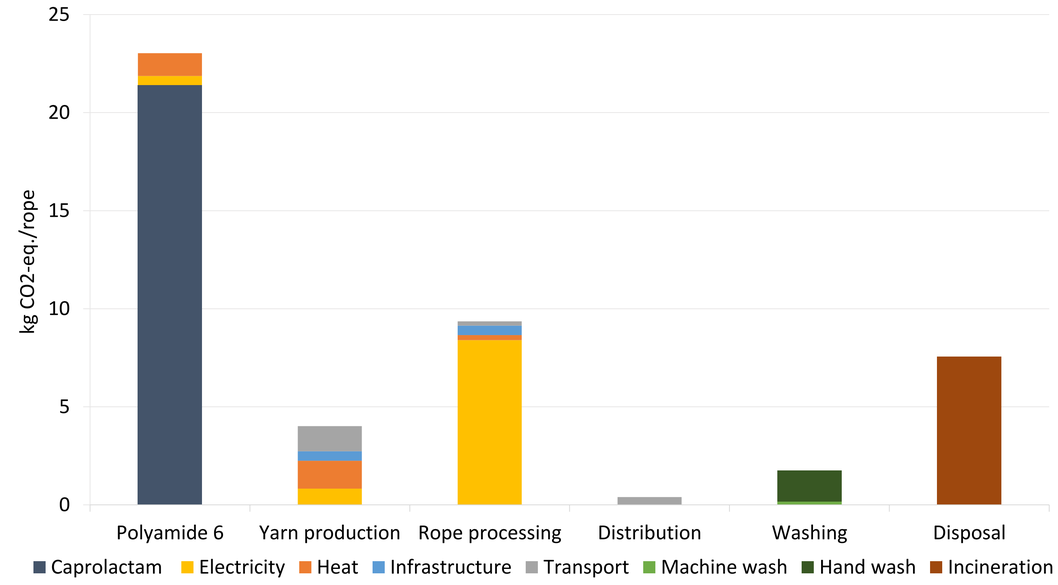


Figure 2. Greenhouse gas emissions in kg CO_2-eq. of the climbing rope (60m with a weight of 3.54 kg) during its life cycle, assessed with the IPCC 2013 100a method [3]

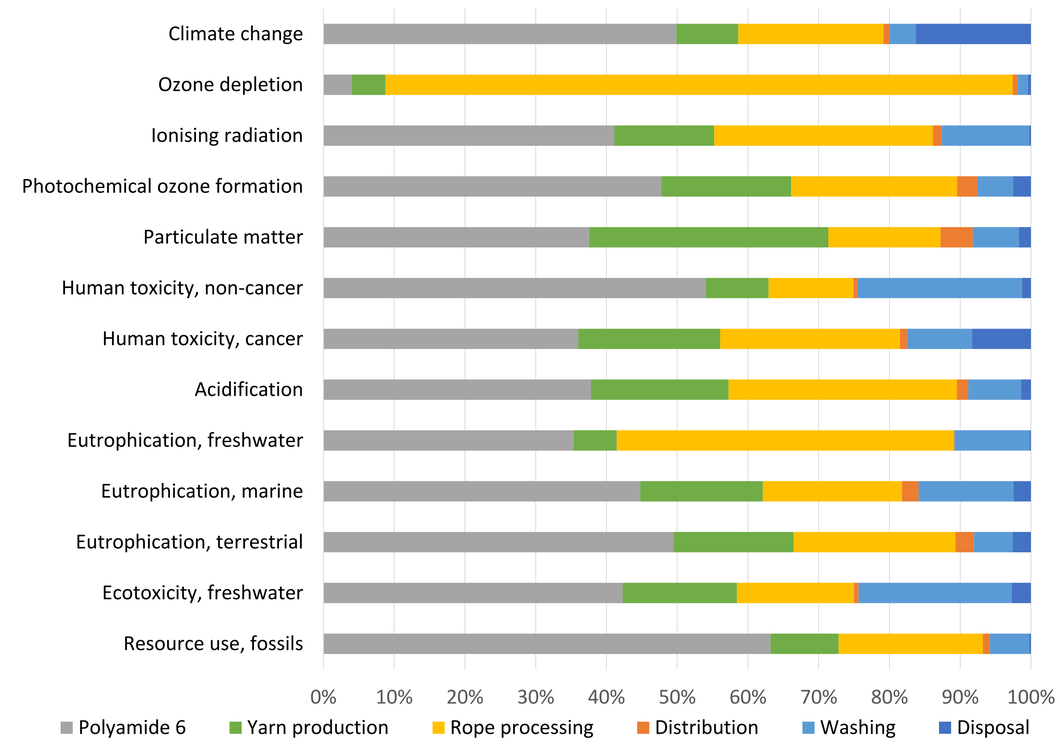
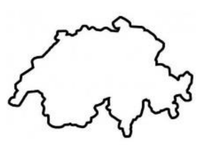


Figure 3. Relative environmental impact during the life cycle of the climbing rope, based on the Environmental Footprint (EF) and IPCC 2013 100a method (greenhouse gas emissions) [3]

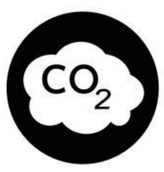
Discussion and Conclusion



High likelihood among climbers of participating in a recycling project for old ropes based on online survey (Switzerland: 63,900 climbers)

Based on extrapolation: 226 tons of old ropes stored at home or used for non-climbing purposes by Swiss climbers

With 226 tons of old ropes 1.6 million recycled T-shirts could be produced



The recycling of the old ropes would lead to GHG savings of 1170 tons CO2-eq.

References

1. Adams, A.; Zimdars, C. Climate Strategy (non-public report). Quantis, 2019.
2. MAMMUT Sports Group AG. Ropes—Overview; MAMMUT Sports Group AG: Seon, Switzerland, 2019.
3. Bradford, S., Rupf, R., & Stucki, M. (2021). Climbing Ropes—Environmental Hotspots in Their Life Cycle and Potentials for Optimization. Sustainability, 13(2), 707. doi:10.3390/su13020707